FACTS
FOR ENVIRONMENTAL STUDIES

Ontario Ministry of the Environment

noise
AIR
WATER
PESTICIDES
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about pollution

TO THE TEACHER:

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DISCUSS THE PROBLEMS CONCERNING TI ENVIRONMENT USING THESE WORK SHEETS AS A WAY OF GENERATING INTEREST.

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concerned about pollution...

so

Keep your car well-tuned and in good working condition.

Get "back to nature" via your own two feet. Walk, ski, snowshoe or sail instead of using powerboats, trailbikes or snowmobiles.

Avoid unnecessary packaging and extra wrapping. Carry small purchases home without a paper bag.

Buy drinks in returnable containers.

... do something about it!

FACTS FOR ENVIRONMENTAL STUDIES

Ontario Ministry of the Environment

ABOUT AIR POLLUTION

AN INTRODUCTION TO AIR POLLUTION IN ONTARIO

Air pollution is a matter of vital concern to us all. Air is our main link with life, far exceeding our dependence on food and water. An adult human might live six weeks without food or three days without water, but would survive only minutes without air. Air quality must be protected.

What Is Air Pollution?

In simple terms, air pollution exists when certain substances are present in the atmosphere in sufficient concentrations to adversely affect the environment. Air pollution is not new. It is caused by a variety of natural phenomena as well as by human activities, and has been present since the earth began.

Natural air pollution results from volcanic eruptions, earthquakes, natural decay of organic material and forest fires. The wind acts as a natural carrier of the pollutants from these sources.

Man began contributing to air pollution with his first fire, and has continued to do so through the industrial ages of copper, bronze, iron and steel, right to the present age of atomic power and space travel. Strange as it may seem, however, man is not the biggest polluter on earth. On a sheer weight basis, nature produces more air polluting material than man. But man outdoes nature in the production of sulphur dioxide and carbon monoxide. The environment is capable of handling natural pollution, but not mankind's.

British history shows that air pollution has been a problem in that country for many centuries. In 1257, the smoke of Nottingham was so bad that Queen Eleanor, who was staying there while Henry III led an expedition into Wales, was compelled to move to Tutbury. Edward I issued a royal proclamation in 1306 prohibiting the use of coal in certain furnaces. Punishment for the first offense was a fine; for the second, demolition of the furnace; for third, execution. One such execution actually took place.

In 1661, coal smoke was so bad in London that the diarist John Evelyn, in writing about it, stated, ". . . the weary Traveller, at many miles distance, sooner smells, than sees the City".

It was in England, in the 19th Century, where the first attempts to control smoke on a community basis were made. The first anti-smoke ordinance was adopted in 1857. In the United States, the first such law was put into force in Chicago in 1881. Toronto passed such a bylaw in 1907, the first in Canada.

In the early part of the century, programs were designed to control visible emissions, primarily smoke. It is only in the last 20 years that legislation has been passed concerning invisible air pollution. During this period, the problem has commanded the attention of professionals from many specialized disciplines — engineering, law, public administration, economics, medicine, and numerous areas of pure science.

Air is a natural resource, and for this reason it must be protected from pollutants. However, the need to protect air from pollution arises when there is or might be an adverse effect on such things as human health, vegetation, or buildings.

Air pollution is caused by two things: emission of undesirable substances into the atmosphere; and transportation of these substances in the atmosphere from their source to a receptor, in some cases many miles away. The effect is always associated with a time/concentration relationship. This simply means that in order to experience an air pollution episode, the receptor must be subjected to definite concentrations of pollution-laden air over definite periods of time.

Ontario has adopted a policy of air quality management which demands pollution criteria below any level known to produce a hazard to health or discomfort to man or livestock, or which would damage vegetation or cause corrosion and soiling of buildings. The emission limits are such that if everyone complies with the standards, hazards to health and property will not materialize. This is accomplished by enforcement of the Environmental Protection Act of 1971 and its subsequent amendments.

The degree of control is tailored to each individual situation, but each case meets the same standards because the time/concentration of the pollution is measured at the point of reception, not at the point of emission. Formulae have been worked out which can be used to predict the rise and dispersion of emission plumes when they leave the smokestacks.

An important aspect of Ontario's air management program is its air pollution index and alert system. The index was established to give warning of, and to prevent the adverse effects of air pollution build-ups. The index network covers all of the major centres in the province.

The index is based upon continuous measurements of sulphur dioxide and suspended particulate matter. Both of these pollutants have been found in high concentrations during severe air pollution episodes.

The structure of the index is a numerical scale beginning at zero. Readings below 32 are considered acceptable. API Readings of sulphur dioxide and suspended particulate matter below 32 should have little or no effect on human health. At 58, people with chronic respiratory disease may be affected. At 100, prolonged conditions could have mild effects on healthy people and serious effects on those with severe cardiac or respiratory disease.

The alert system functions at four index levels — 32 (advisory level), 50 (first alert), 75 (second alert), and 100 (air pollution episode threshold level). At 32, if meteorological conditions are expected to remain unfavourable for at least six more hours, owners of major sources of air pollution may be advised to prepare for possible curtailment of their operations. At 50 and 75, under continuing adverse meteorological conditions, they can be ordered to curtail operation.

At 100, the Minister of the Environment can order all operations resulting in air pollution not essential to public health or safety to close down. A reading of 100 is unlikely to be reached because of provisions for curtailment made at lower index levels. However, due to the unpredictable nature of natural weather phenomena, it is necessary to plan for such total curtailment actions.

Legislation in Ontario

The foundation for air pollution control in Ontario lies in the Environmental Protection Act, 1971, and in its various amendments. Under this Act, the Ministry of the Environment inspects and regulates all possible sources of air pollution. It conducts monitoring programs of air quality throughout the province. It establishes air quality objectives and emission standards for all sources of air pollution. It conducts meteorological studies and research into pollution abatement technology. In cases where air pollution discharges create immediate and serious dangers to public health, the act gives the Ministry of the Environment the authority to stop operations causing the discharges. It can also initiate legal action for violation of either a regulation made under the Act, or of a Minister's order issued to correct a pollution condition. Maximum fine for an individual is $2,000; for a corporation, $5,000 on the first conviction and $10,000 on the second. Each day that a violation occurs constitutes a separate offense.

Numerous regulations have been made under the act. Of special importance is the establishment of the air pollution index, standards for emitted contaminates, and air pollution emission standards for motor vehicles, ferrous foundries, and asphalt paving plants.

Sources Of Air Pollution

Air pollution is a major by-product of a civilization that has become dependent upon industrial technology for survival. Our age is dependent on complex production techniques, sophisticated forms of transportation for delivery of raw materials and manufactured products, centralized energy and heat sources, and intricate urban structures. All of these contribute to air pollution. Basically, air pollution is caused by three major processes: combustion, vaporization, and mechanical attrition.

The combustion of fossil fuels for heat, steam, and electrical energy is the cornerstone of our technological society. Without these commodities, our society as we know it could not exist. The by-products of combustion — smoke and gases — comprise what is known as "contaminant plumes", familiar trademarks of all industrial areas.

Vaporization, or volatilization, is a by-product of many chemical and manufacturing operations. Vaporization includes the evaporation of volatile materials at normal atmospheric temperatures and pressures, fuming as a result of induced temperatures, and decomposition of organic materials due to natural processes. Fuming includes both volatilization and condensation. It takes place in acid manufacturing and handling, and in metal melting operations where molten metal liquids are first volatilized to the gas state and then condensed to dusts by rapid cooling. Decomposition is associated with the handling of highly organic compounds or animal tissue with nitrogenous or sulphurous contents.

Mechanical attrition includes crushing, grinding, drilling, sweeping, sanding, pulverizing, atomizing, and similar operations, all of which disperse particulate matter in the form of dusts or mists into the atmosphere. Other forms of mechanical attrition include transportation of dust and salt residues by traffic on highways.

Types of Air Pollution

Air pollution consists of aerosols and particulates (basically mists and dusts) and gases (both organic and inorganic).

Particulate matter is responsible for soiling, corrosion, and damage to clothing, property, and vegetation. It is also the cause of human respiratory ailments. Particulate matter may include toxic substances such as cancer-causing and radioactive materials.

Aerosols tend to remain suspended permanently in the air. They are usually emitted either in aerosol form or they may evolve from the fracturing or decomposition of large particulates. They also form in the air from the condensation and nucleation of gases. They may be organic or inorganic in composition, and either liquid or solid in form.

The smaller the aerosols, the more they be

have like a gas. Aerosols, therefore, are not as readily deposited as the particulates and may be inhaled and exhaled with air. Aerosols are also undesirable because of their ability to reduce visibility through the process of light scattering.

The organic gas pollutants are hydrogen-carbon compounds and their derivatives.

The principle origin of hydrocarbons is petroleum released into the atmosphere during the refining, transfer, storage, and use of fuels, lubricants, and solvents. Hydrocarbons are also formed in the atmosphere by photochemical reactions.

The most important source of hydrocarbon emission in urban centres is the gasoline-fueled motor vehicle. The exhaust emissions from motor vehicles are a major source of air pollution. They contain water vapor, carbon dioxide, carbon monoxide, oxides of nitrogen and unburned hydrocarbons. Lead may exist if it is used as an anti-knock agent in the gasoline.

Automotive pollutants result from the incomplete combustion of fuel. Where there is sufficient oxygen, hydrocarbon fuel is completely converted into carbon dioxide and water vapor. Incomplete combustion produces carbon monoxide, hydrocarbons, and oxides of nitrogen. Incomplete combustion can occur for a number of reasons — poor mixing of air and fuel, short combustion time, quenching of the combustion process near a cool chamber wall, or dead space where the combustion flame cannot penetrate.

Some of these problems can be reduced or eliminated by fine tuning of the carburetor and timing mechanism, by heating the air or fuel prior to mixing, or by replacing the standard carburetor with a fuel injection system. The introduction of vehicle emission standards has forced some manufacturers to incorporate catalytic converters into their engine exhaust systems However, lead has a poisoning effect on the catalyst, so the system can only be used with gaseous fuels, diesel fuel, or lead-free gasoline. The manufacturers, however, claim that a "few tankfuls" of leaded gasoline will not permanently destroy the effectiveness of the catalyst. Unfortunately, it has been found that the catalytic converters create an air pollution problem in the form of a sulphuric acid mist.

Recently a modified, low-pollution form of the internal combustion engine was introduced to the North American market. This is the stratified-charge engine, which appears to have great potential for complying with projected emission standards. Other power systems that are being developed as long-term possibilities are a Stirling engine, a Rankine engine (a modified steam engine), and a gas turbine, as well as various gasoline-electric hybrids.

The other major class of hydrocarbon contributors consists of petroleum references, petrochemical plants and industrial and commercial users of organic solvents. They and their counterparts in the petroleum industry account for 98 per cent of all hydrocarbon emissions.

Hydrocarbons and their derivatives contribute greatly to pollution because of their role in the production of photochemical smog. Most reactive are the unsaturated hydrocarbons. They can react with nitrogen dioxide to produce visibility-reducing oxidants (primarily ozone) which can also cause damage to vegetation. Saturated hydrocarbons and aromatic hydrocarbons can also react with nitrogen dioxide to produce a similar variety of contaminants which irritate the membranes of the human eye and lungs.

The major inorganic gases are oxides of nitrogen, oxides of sulphur, and carbon monoxide. The principle source of the oxides is fuel combustion — industrial, commercial, and domestic for purposes of transportation, space heating, and power generation.

There are many oxides of nitrogen, but only nitric oxide (NO) and nitrogen dioxide (NO^2) are important as air contaminants. Nitric oxide is formed when atmospheric nitrogen is oxidized during fuel combustion in automobiles, incinerators, and industrial furnaces. The amounts produced are in direct proportion to fuel consumption, increasing greatly at high temperatures.

Once in the atmosphere, nitric oxide is then able in the presence of sunlight to combine with available atmospheric oxygen to form nitrogen dioxide. one of the major ingredients of photochemical smog. Oxides of nitrogen have increased in quantity lately, largely due to the greater compression ratios in engines of late model motor vehicles.

Only two oxides of sulphur — sulphur dioxide (SO^2) and sulphur trioxide (SO^3) — are classified as air contaminants. They are formed primarily during the combustion of sulphur-containing fuels such as coal and oil. Consequently the amount of oxides of sulphur that are produced depends directly on the sulphur content of the fuel and on fuel consumption. Gaseous oxides of sulphur are of concern because of their toxicity and their ability to react with water vapor to form an irritating sulphuric acid mist. They have been associated with human respiratory illness caused by severe air pollution.

Each oxide can combine with water in the air to form toxic acid aerosols that corrode metal surfaces, fabrics, and plant leaves. Sulphur dioxide, in particular, causes damage to vegetation. In concentrations as small as 5 parts per million (ppm), sulphur dioxide is irritating to the eyes and respiratory system. It is colorless, but has a characteristically pungent, suffocating odor.

Carbon monoxide (CO) results from the incomplete combustion of carbonaceous fuel. Automobiles are the principle source, contributing as much as 97 per cent of the total amount in a large metropolitan area. The exhaust from an individual automobile is 1 to 5 per cent carbon monoxide, depending upon carburetor adjustment. Although produced in enormous quantities throughout the world, carbon monoxide forms only 0.00001 per cent of the atmosphere. It is presumed that most of it is oxidized to form

carbon dioxide (CO^2).

Carbon monoxide is poisonous to man and animals. In high concentrations, it acts as an asphyxiant interfering with the blood's ability to carry and release oxygen. Initial symptoms are slight headache and shortness of breath. In sufficient concentrations it is lethal.

Injury to crops and trees resulting from air pollution has been clearly established. It can range from visible markings on foliage to reduced growth and yield, and even to premature death of plant life. The economic consequences can, at times, be disastrous. Injury to crops possessing marketable foliage such as lettuce or tobacco can result in especially high losses.

Vegetation injury often serves as a warning to man of the presence of toxicants that may also affect human health poison foraging cattle.

Vegetation in Ontario suspected or known to have been injured by air pollutants includes ornamental flowers, garden fruits and vegetables, stored vegetables, greenhouse flower crops, farm crops, animal pastures, cured hay, and fruit and forest trees. Suspected air pollutants, and those ascertained as having caused vegetation injury, include fluorides, sulphur dioxide, oxidants, boron, lead chlorine, hydrogen chloride, chromium, nickel, salt spray, urea, nitrogen dioxide, ammonia, cement dust, and magnesium-lime dust. Any pollutant that injures vegetation is known as a phytotoxicant.

The symptoms of injury caused by phytotoxicants can be very similar to those of injuries caused by disease, insects, adverse weather, poor nutrition, or crop mismanagement. All suspected cases of air pollution injury require careful diagnosis by specialists.

The protection of plants from the adverse effects of aerial phytotoxicants cannot be carried out in exactly the same manner as is possible with disease-causing, organic reproductive bodies. A pollution-diseased plant cannot infect other plants; there is no need for quarantine or for eradication of affected plants. The development of resistant varieties holds some promise. The best control method, however, is to reduce the concentrations of noxious pollutants at their sources.

Soiling and property damage. One of the first material effects of air polution is the soiling of clothing, buildings, and other properties. Air pollution has a direct influence on the cost of cleaning and laundering, the marketability of merchandise, and the cleaning of buildings. It is responsible for considerable economic loss.

Property damage is usually of a cumulative nature. It tends to shorten the durability of materials exposed to the atmosphere. It is generally caused by the interaction of contaminants with the surface or protective coatings of materials. Typical effects are metal corrosion, stone and masonry deterioration, and damaged automobile paint work.

Effects on human health have been most dramatic during so-called air pollution "episodes". These are fortunately rare. They occur when stagnant weather conditions allow a concentration of air pollutants to build up over a period of several days. At such times, people with severe chronic respiratory disease are greatly affected and many excess deaths can occur.

In general, toxicologists maintain that concentrations of carbon monoxide would have to exceed 500 ppm for at least one hour before a detectable effect upon human health is produced. Carbon monoxide has been detected in urban atmospheres at concentrations ranging from substantially 0 to 150 ppm. Greater concentrations have occasionally been measured in confined spaces such as tunnels and poorly ventilated garages.

Hydrogen sulphide can cause discoloration of certain kinds of paint and is toxic at certain concentrations. Ammonia can discolor certain fabric dyes and is corrosive to copper, brass, aluminum, and zinc. Chlorine can discolor certain fabric dyes. Fluorine and fluorides, especially hydrogen fluoride, are highly toxic and corrosive. They can cause damage to vegtation, and illness and injury to humans and animals.

Effects Of Air Pollution

As air pollution increases, certain effects become apparent. Visibility is reduced, vegetation is injured, property and clothing are soiled, and most vital of all, human health is affected.

Reduction in visibility is due to the concentration of aerosols in the atmosphere. There are two basic effcts: a darkening of the sky, and haziness due to scattering of light. Sky darkening is the physical obstruction of sky illumination by clouds containing smoke and fumes. Haziness is the alteration of sky illumination due to light scattering. The blue color of the sky is the result of sunlight being scattered by molecules of atmospheric gases. Similarly, the color of the sky can be changed by pollution hazes. The type and degree of change depend upon the size of aerosols present, relative to light wave length.

Visibility reduction is an indication of pollution accumulation. Its measurement is one way in which pollution intensity can be determined. Visibility records can be used to show daily, weekly, monthly, and yearly variations. They reflect not only weather variations, but also changes in industrial practises and in the effects of pollution control procedures.

As the sky is darkened, either by normal cloud or pollution effects, the amount of available sunlight reaching the ground is reduced. Sunlight is essential to human and plant life. Its obstruction due to any cause can be a serious matter if it occurs often or over prolonged periods of time.

Serious pollution episodes have occurred in various parts of the world. In Donora, an industrial community located in a deep valley 30 miles south of Pittsburgh, thousands of people became ill, several hundred were hospitalized, and 20 died when air pollutants from mills, smelters, and acid plants accumulated during a calm period of

weather in October of 1948 and did not disperse for 4 days. In London, England, a much more serious episode occurred in December, 1952. During a period of calm weather, air pollutants became so concentrated that 4,000 deaths resulted from various respiratory diseases both during and after the episode.

The effect of day-to-day exposure to lower concentrations of air pollution is very difficult to assess. Some individuals are relatively susceptible, others are less so. On the whole, people who live in industrial centres have an increased chance of getting certain diseases of the respiratory system.

Some forms of air pollution are more annoying than harmful. This is true of many unpleasant odors. Where the main source of pollution is the automobile, the air may cause the eyes to water and the throat to be irritated without having any apparent lasting effect. Much research is still required to determine the long-term effects of exposure to polluted air.

Meteorology And Air Pollution

Meteorological factors greatly affect the dispersal or concentration of pollutants in the atmosphere. Temperature and solar radiation, by their infuence on the amount of space heating required, affect the quantities of pollution emitted. Sunshine is required for the photochemical production of oxidants that form smog. Wind velocity, turbulence, and stability affect the transport, dilution, and dispersion of pollutants. Rainfall washes particles and gases from the atmosphere depositing these on land and water. Finally, humidity is a frequent and important factor in determining the effect of pollutant concentrations on property, vegetation, and health.

Wind. Wind is air in motion in three dimensions. Only the horizontal component, however, is usually considered in terms of direction and speed. Wind direction indicates direction of travel of pollutants. It is a very important factor in predicting the air pollution potential of an area in which the principal pollutant sources are high-stack emitters located close together. Wind direction is less important where low-level emitters such as low smokestacks and automobiles cause most of the pollution.

Expected persistence of wind direction must be considered when forecasting air pollution potential and selecting sites for plants. Topographical features such as valleys cause winds to persist in certain directions at much greater frequency than others. Obviously, polluting industries should not be located in such areas.

Wind speed determines the travel time of pollutants from a source to a receptor. Wind speed also has a dilution effect. This dilution effect is not true for hot emissions from high-stack sources. In these instances, an increase in wind speed lowers the plume rise, thus tending to increase ground level concentrations. There is a "critical wind speed" for each stack design at which concentrations downstream reach a maximum.

Turbulence. High frequency fluctuations in the wind are known as turbulences. They occur both vertically and horizontally. These random motions are responsible for the movement and diffusion of pollutants about the wind path.

Mechanical turbulence is caused by roughness of terrain such as trees, shrubs, and buildings. Thermal turbulence is due to the earth's surface being heated by the sun. Thermal eddies develop as the air, heating up at lower levels first, becomes less dense and rises.

Temperature. The temperature of the lower region of the atmosphere (from the surface to 2 kilometers) can either decrease or increase with height, depending on the character of the underlying surface and the radiation at the surface. During the day, temperature usually decreases with height. As a result, the warmer air near to the ground and the pollutants emitted into it rise and disperse high into the atmosphere. Concentrations of pollutants in the lower layers of the atmosphere are relatively low.

When the reverse occurs and temperature increases with height, a temperature inversion is said to exist. An inversion inhibits the rise and dispersal of pollutants emitted into the atmosphere. Thus, when pollutants are emitted near the ground during an inversion, they remain and high concentrations develop.

Reducing Pollution Emissions

When the emission of an air contaminant cannot be entirely prevented or eliminated, its amount can still be reduced to a level that will not be harmful to either humans, animals, vegetation, or property. This is done by abatement devices and equipment at the source. In certain instances, where no practical method of reducing the contaminant at the source exists, a tall stack will be permitted to disperse it over a wider area, thus reducing ground level concentrations. In this way, the effect is reduced. However, dispersion is considered an interim measure only. The ultimate goal is elimination of pollutants at their source.

The major goal of air management in Ontario is the steady improvement of ambient air quality across the province. Desirable air quality criteria have been established for a wide range of contaminants.

The criteria for sulphur dioxide are: 0.25 ppm, parts of air by volume averaged over a period of one hour; 0.01 ppm averaged over 24 hours; 0.02 ppm averaged over one year.

The criteria for suspended particulate matter are: 90 micrograms per cubic meter of air averaged over a period of 24 hours; a geometric mean of 60 micrograms per cubic meter for a period of one year.

These values are considered as objectives or goals and are used to assess existing air quality, evaluate progress, and predicate abatement strategies.

Intergovernmental Cooperation

Ontario directly shares an international boundary with three American states. Because of the problems of transboundary air pollution, the provincial government is involved in various programs at both federal and province-state

levels, much of it through the International Joint Commission. The I.J.C., established by the Canadian and American governments, does not have any regulatory powers, but does have powers to conduct comprehensive investigations and to recommend corrective actions.

Financial Assistance

There are several ways in which companies, institutions, and municipalities can obtain financial assistance for the installation of air pollution control equipment. They can apply for grants up to the amount of the provincial sales tax paid on the equipment, obtain Ontario Development Corporation loans, receive certain federal sales tax exemptions, and take advantage of accelerated capital cost allowances.

Grants are also available through the Ministry of the Environment to universities and other organizations for research.

Air Management Organization In Ontario

The management of air in Ontario is the responsibility of the Ministry of the Environment, which is divided into four divisions for administrative purposes. The Environmental Assessment and Planning Division establishes the air management programs and sets policies, standards, and criteria.

Much of this work is also done by the Air Resources Branch which is divided into five sections: Criteria Development and Program Planning, Air Quality and Meteorology, Vehicle Emissions, Phytotoxicology, and Technology Development and Appraisal.

The Pollution Control Branch and the Environmental Approvals Branch of the Environmental Assessment and Planning Division also concern themselves with air management.

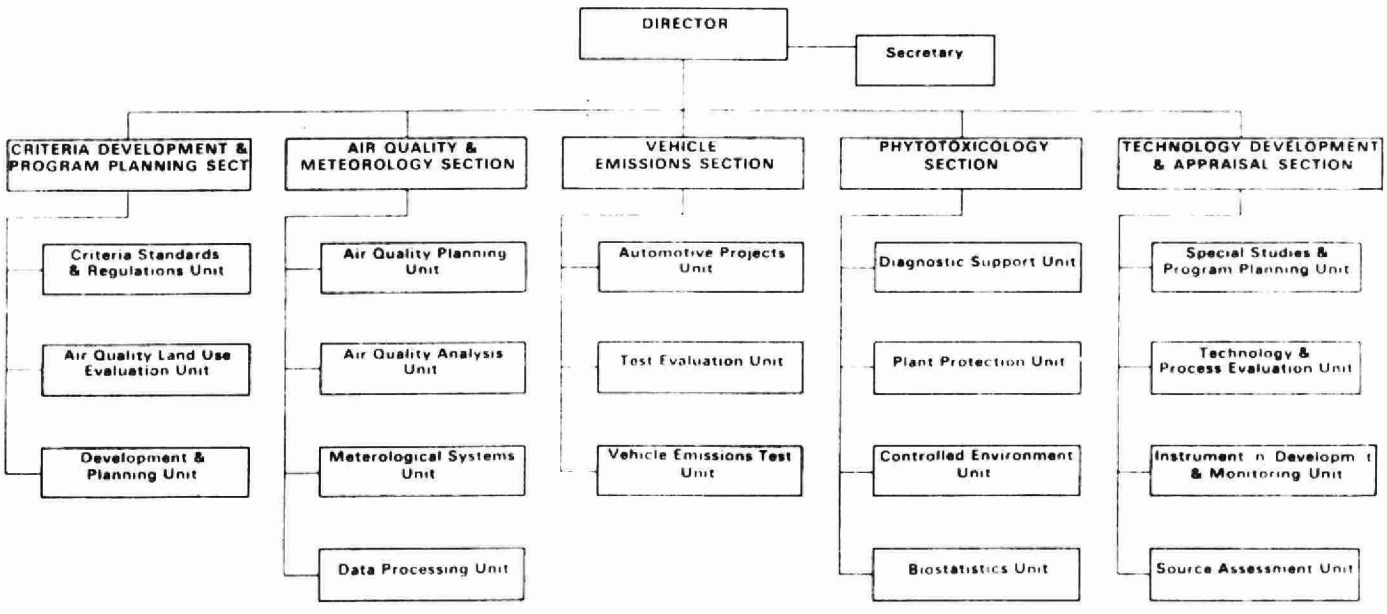
The Utility and Laboratory Services Division is responsible for research and technical services. Its Laboratory Services Branch has an Air Quality Laboratory Section.

The Regional Operations Branch is responsible for the implementation of air management policy and programs throughout Ontario. Inspection of polluters and investigation of complaints are carried out by the six regional offices, located in Toronto, Hamilton, London, Kingston, Sudbury, and Thunder Bay or by district and subdistrict offices throughout the province.

Conclusion

Air pollution remains a serious concern in certain parts of Ontario. However, a considerable amount of progress has been made, and major improvements are forthcoming. Within the next few years, virtually all sources of air pollution in the province will be under control, emitting either no contaminants at all or contaminants at acceptable levels of concentration. When this degree of control has been achieved, pollution buildups will not occur.

AIR RESOURCES BRANCH



FACTS
FOR ENVIRONMENTAL STUDIES

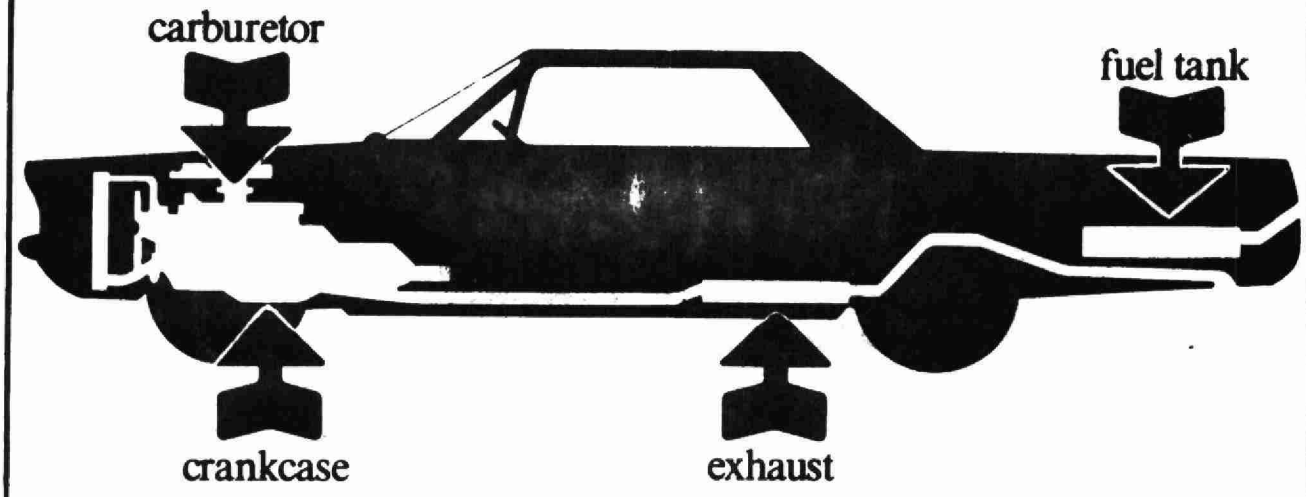
Ontario Ministry of the Environment

ABOUT AIR

AIR POLLUTION AND THE AUTOMOBILE

(This Fact Sheet was prepared to assist students interested in carrying out environmental studies.)

The Source of the Problem



There are four sources of air pollution on your car:
1. exhaust system (exhaust gases)
2. crankcase (blowby gases)
3. carburetor (evaporating fuel)
4. fuel tank (evaporating fuel)

Control systems and devices developed to reduce the emission of unburned gases and evaporating fuel vary according to manufacturer. But they must all meet emission standards laid down in Government regulations.

Everyone who walks on a street heavily travelled by cars, trucks and buses knows that motorized vehicles produce noxious and irritating exhaust gases. But the unpleasant odour of these gases is only a small symptom of a much bigger problem.

Gases from automobile exhausts can be dangerous, and are a major source of air pollution. In addition to carbon dioxide and water vapor, automobile exhaust contains carbon monoxide, oxides of nitrogen, unburned hydrocarbons and lead. Of these, carbon monoxide, when concentrated in an enclosed space, can be lethal.

I. Causes Of Automobile Pollution

Automotive pollutants result from evaporation or incomplete burning of fuel. When there is sufficient oxygen, hydrocarbon fuel is completely converted into carbon dioxide and water vapor. However, incomplete combustion, in addition to producing these two gases, also produces carbon monoxide and hydrocarbons. In addition, under some conditions, nitrogen in the air-fuel combustion mix can be oxidized.

Incomplete combustion can occur for various reasons, including poor mixing of air and fuel, short combustion time, quenching of the combustion process near a cool chamber wall or dead space where the combustion flame cannot penetrate. Some of these problems can be eliminated by heating the air or fuel prior to mixing, or by replacing the standard carburetor with a fuel injection system. **Crankcase emissions** can be eliminated by using a closed PCV (positive crankcase ventilation) system that feeds crankcase vapors back to the air intake system to be burned in the combustion chamber.

When a car is stationary, particularly when its engine is hot, gasoline can evaporate through either the fuel tank breather tube or the carburetor, thus becoming another source of automo-

tive pollution. This type of pollution can be greatly reduced by installing an activated charcoal filter that absorbs escaping vapors. When the car engine is started, air is sucked through the charcoal filter, extracting the fuel vapors. The mixture then passes through the air filter into the engine, where it is burned.

II. Controlling Automotive Pollution

Until 1971, regulations controlling automotive pollution existed only at the provincial level. Ontario, in fact, was the first province to pass legislation in this area. These regulations reduced pollution from 1969 model cars up to 50 per cent. Subsequent regulations for 1970 reduced emissions even further.

Since January 1, 1971, the control of air pollution from motor vehicles has been a joint federal-provincial responsibility. The federal government now establishes all emission standards for new vehicles and enforces them at the manufacturing level. Provincial governments are responsible for the control of pollution caused by emissions from vehicles after they have been sold. The joint federal-provincial controls now result in 1975 model cars emitting only 20-25 per cent of the original uncontrolled levels of pollution.

In Ontario, the provincial agency responsible for the control and prevention of air pollution is the Air Resources Branch of the Ministry of the Environment. The control of pollution from motor vehicles is the special responsibility of the branch's Vehicle Emissions Section.

This section works in several ways to lessen automotive pollution. It assesses, on a continuing basis, the effectiveness of exhaust emission controls and ensures compliance with the Environmental Protection Act, 1971, by conducting spot-checks on vehicles in various parts of the province. The Act makes it an offence to remove exhaust emission systems or to operate a vehicle with the system removed or inoperative. The Act also provides for a maximum fine of $5,000.

The vehicle emissions section also conducts experimental programs relating to new types of automotive control systems. It provides an educational service to automotive mechanics (in the trade and at community colleges) to illustrate the importance of the proper use of analytical equipment and proper tune-up procedures in emission reduction. In addition, it operates a pilot program to reduce visible emissions from heavy duty vehicles, and promotes public awareness of the necessity to keep vehicles regularly and properly maintained.

III. Exhaust Control Methods

a) **Engine modification systems** involve redesign of the engine to produce more efficient combustion, and therefore lower concentrations of pollutants. Engines equipped with engine modification systems have carburetors of a leaner air fuel mixture, usually a ratio of about 14:1 to 15:1. The spark timing is advanced or retarded for better combustion depending on the particular mode of vehicle operation. Some of the exhaust gas is also recycled through the engine to reduce nitrogen oxide formation.

b) **The air injection system** uses an air pump to force air into the exhaust manifold of the car engine. The temperature of the air-exhaust gas mixture is high enough to induce more complete combustion. As a result, most of the polluting gases are burned to form carbon dioxide and water vapor.

c) **The fuel injection system** accurately meters a fixed amount of fuel and air to each combustion chamber of the vehicle's engine. Better combustion can be achieved with this approach than with the more conventional carburetor system. For example, fuel injection cuts off the fuel supply completely during deceleration, while a carburetor system causes high pollutant output at this time.

d) **Catalytic mufflers** containing certain types of catalysts can be used to oxidize carbon monoxide and hydrocarbons. However, this system can only be used with liquid propane and other gaseous fuels, diesel fuel and unleaded gasoline, because lead can create a poisoning effect on the catalyst.

In the past few years, there have been a number of encouraging developments in the area of automotive pollution control. A large public utility has tested dual-fuel vehicles. These cars use gasoline on the open highway and either propane or natural gas in congested areas and stop-and-go traffic. Although this system does reduce the emission of pollutants, it has one disadvantage. For best fuel economy, the carburetion system requires different settings for combustion of gasoline and gaseous fuel. Therefore, in order to operate on both fuels alternately, the setting must be at an intermediate position, giving a less economic use of both fuels.

Tests have suggested that car engines using natural gas or propane can operate with lower emissions and for considerably greater mileages between maintenance checks than those using gasoline. This is due to an absence of both spark plug fouling and engine oil dilution. However, because of fuel supply and distribution problems, this type of system is likely to be of benefit only to fleet operators whose vehicles return each night to a central refuelling point. It is unlikely to become an everyday fuel for the average motorist.

IV. The Lead Controversy

The use of lead-free and low-lead gasoline in vehicles with non-catalyst controls is not expected to significantly reduce emissions of the main pollutants — carbon monoxide and hydrocarbons — although a number of conflicting reports have been issued on this topic. Some reports state that the use of lead-free fuel increases the emission of hydrocarbons, particularly those with high smog-forming potential. Others indicate that the use of such fuel will bring about a decrease in hydrocarbon emissions. This conflict can be resolved, however, if vehicles are divided into two groups based on their ability to use lead-free gasoline. In the

following cases, it is assumed that a lead-free gasoline of sufficiently high octane is available to satisfy the octane requirement of an engine as a result of its compression ratio.

Pre-1971 vehicles which have been operated for a considerable period on leaded gasoline have a protective layer of lead on various engine parts. A switch to unleaded fuel should produce no adverse effects. However, if the combustion chambers and associated parts are cleaned, this would expose metal surfaces that would be damaged by subsequent engine operation with unleaded gasoline. A possible solution is to operate such vehicles for a few hundred miles on leaded fuel, followed by general use of unleaded gasoline. It would probably be necessary to repeat the use of leaded gasoline at intervals to ensure a replacement of the protective lead coating.

1971 and later model vehicles have, for the most part, been manufactured for satisfactory operation on 91-octane, lead-free gasoline. Use of this fuel poses no problem.

The use of lead-free gasoline will help reduce the total amount of lead being emitted into the atmosphere. In addition, lead-free gasolines are necessary for the satisfactory operation of catalytic mufflers that have been installed on some vehicles since the start of the 1975 model year.

One automotive pollution control development introduced in 1975 was the stratified charge engine. Theoretically, if an engine can burn a very lean air/fuel mixture, low amounts of pollutants will be produced. In practice, when the conventional internal combustion engine burns very lean mixtures (greater than 17 parts of air to one part of fuel), considerable misfiring occurs, due to the difficulty of getting the mixture to ignite. Fortunately this problem has been overcome in the stratified charge engine. This engine has a similar configuration and operation to a conventional engine except that the combustion chamber is modified to incorporate a main chamber and an auxiliary combustion chamber. The modified carburetor injects a very lean (22:1) air/fuel mixture into the main combustion chamber, and a rich, easily ignitable mixture (14:1) into the auxiliary chamber. The spark plug ignites the rich mixture, producing a vigorous flame which then ignites the lean mixture. The auxiliary chamber is much smaller than the main chamber, so the pollutants produced by the rich mixture do not significantly offset the low pollutants production of the main chamber. Another advantage claimed for this configuration of combustion chambers is its ability to allow low-octane fuels to be used in the engine.

V. Some Additional Facts

1) The number of automobiles increased in Ontario from 1,647,379 in 1959 to 2,501,718 in 1969 and will be over 3,000,000 in 1975.

2) In Ontario alone, about 2,250 tons of solid hydrocarbons are released into the air each day. Over a third of that is released in Toronto.

3) It is estimated that about half the total air pollution is caused by motor vehicles.

4) Gasoline motor vehicles account for approximately 59 per cent of the total carbon monoxide emissions, 32 per cent of the nitrogen oxide, and 47.5 per cent of the hydrocarbons.

5) In recent years, the average car produced 200 pounds of hydrocarbons, 113 pounds of oxides of nitrogen and 2,300 pounds of carbon monoxide per 1,000 gallons of gasoline.

6) An average person breathes nearly 3,500 gallons of air a day.

VI. Questions

1) How has the Ministry of the Environment been active in the area of lessening automotive pollution?

2) Describe in your own words the three major sources of automotive air pollutants.

3) The Ministry of the Environment promoted a "don't top the tank" program. List any reasons you can think of why this program was established.

4) The Ministry's mobile testing laboratories recently tested some "classics" in the Craven Foundation collection of old cars. The results appear in the accompanying table. The 1968, 1969, and 1970 values for carbon monoxide (CO) and hydrocarbons (HO) were the acceptable levels for those years. Calculate the hydrocarbon emissions in p.p.m. per cylinder at idling speed for the 4-cylinder Model T, the 16-cylinder 1931 Cadillac, and an 8-cylinder 1970 auto. What do these tests indicate?

TEST RESULTS

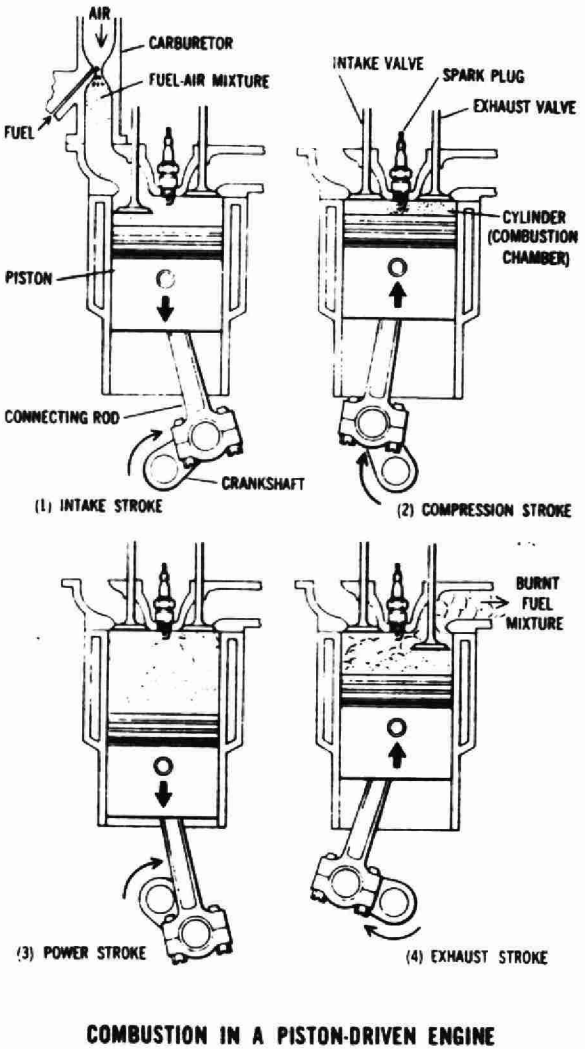
SPEED	CO	HC
1924 Model T Ford Delivery Truck		
Idle	6	550
Fast idle	7.7	250
30 mph	8.5	290
1931 Cadillac V-16 Roadster		
Idle	7.7	1068
Fast idle	7.2	400
30 mph	6.2	230
1968 auto		
Idle	4.5	450
Fast idle	3.0	350
1969 auto		
Idle	3.5	250
Fast idle	1.8	200
1970 auto		
Idle	2.5	200
Fast idle	1.0	150

In the test results above, carbon monoxide (CO) is expressed in percentages and hydrocarbons (HC) in parts per million.

Research Ideas

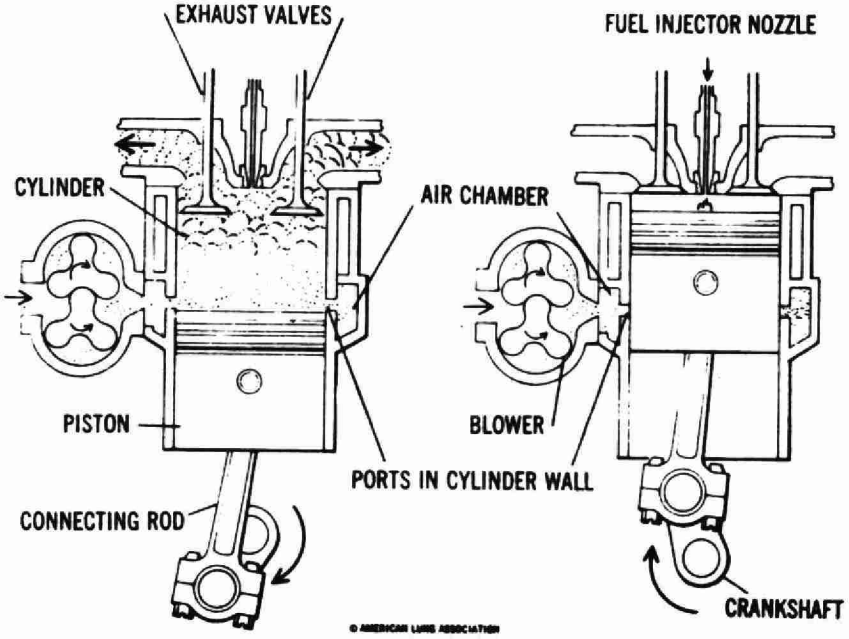
For those interested in literature research, some of the following topics might be considered:

a) the effects of various automotive pollutants on humans;
b) the alternative to the internal combustion engine;
c) the formation and effects of ozone;
d) the formation and effects of photochemical smog.



COMBUSTION IN A PISTON-DRIVEN ENGINE
(One cylinder of a typical automobile engine shown)

On the intake stroke (1), the piston moves down and a mixture of fuel and air is drawn into the cylinder past the open intake valve. With the compression stroke (2), the intake valve closes and the piston moves up and compresses the air-fuel mixture. On the power stroke (3), a spark from the spark plug ignites the heated, compressed mixture, which begins to burn, expands, and pushes the piston down. For the exhaust stroke (4), the exhaust valve opens, the spent, burned mixture exits with its pollutants, and the piston returns to the top of the cylinder.



COMBUSTION IN A DIESEL ENGINE
(One cylinder of a typical diesel engine shown)

With the piston at the bottom of the cylinder (shown left), and exhaust valves and ports open, fresh air is forced into the cylinder by the blower, and the used air-fuel mixture—along with any polluting by-products—left from the previous stroke is forced out. On the second stroke (shown right), the exhaust valves close, the piston rises—shutting off the ports—and compresses the air. When the piston reaches a position near the top of the cylinder, fuel is injected into the now highly compressed, heated air. This heated air ignites the fuel without a spark, and the resulting combustion forces the piston down to its first position.

COURTESY OF THE AMERICAN LUNG ASSOCIATION

FACTS FOR ENVIRONMENTAL STUDIES

Ontario
Ministry of the Environment

Hon George A Kerr Q C
Minister
Everett Biggs
Deputy Minister

ABOUT WATER

INTRODUCTION TO WATER POLLUTION CONTROL

"We travel together, passengers on a little space ship, dependent on its vulnerable supplies of air, water and soil — preserved from annihilation by the care, the work, and I will say, the love we give our fragile craft."

Adlai Stevenson.

An informed public is vitally important in the battle for an improved environment. Governments can proceed only as fast as public opinion dictates. For this reason, it is the responsibility of each of us to spread accurate, factual information about water pollution.

The subject of pollution can be quite complicated and very technical. Because of this, the problems are frequently oversimplified. A detailed understanding of all aspects of pollution really requires a great abundance of reading. And with this in mind, we will try in this publication to put down some basic facts that may help in the search for information.

Introduction

What is meant by pollution? The Oxford Concise Dictionary states that to "pollute" is to "destroy the purity of; make foul or filthy". It sounds simple enough, but pollution means different things to different individuals, and even different things to the same person under different circumstances.

For example, distilled water is commonly considered the purest form of water. Yet, from the standpoint of a fisherman, a lake filled with distilled water would be "polluted", because it would lack the nutrients and minerals necessary for the growth of micro-organisms, invertebrates, and other creatures that serve as food for fish. As a result, fish would not survive in such a lake.

On the other hand, seawater contains a very large quantity of dissolved salts. Yet many marine organisms and fish flourish in it. From this point of view, the oceans could not be called "polluted". However, seawater, because of its salt content, is unsuitable for drinking, irrigation, and many industrial uses. For these purposes it could be considered as contaminated.

Pollution is usually associated with man and his various activities. However, many sources of pollution occur naturally. When leaves fall from trees that overhang bodies of water, organic pollution takes place. Where marshes exist, bacterial organisms enter the water course as a result of decay of aquatic reeds. This natural decay may cause high bacteria counts, which may be wrongly interpreted as indicating pollution from sewage containing disease bacteria and viruses.

Nature's ability to cleanse water exceeds its capacity to pollute it. Nature cleanses water through natural interaction of sunlight, dissolved oxygen extracted from the atmosphere, and by micro-organisms, minute forms of plant and animal life. Nature can cleanse water that has been polluted by natural means, and also in many cases by man-made sources.

However, when man overloads the natural purifying mechanisms of nature or introduces materials that cannot be naturally assimilated, trouble occurs. We then face situations which may be unsightly, unpleasant, or even hazardous to health. It must also be remembered that as the number of humans on the earth increases, with a corresponding increase in technological capabilities, the possibility of the abuse of nature's mechanism becomes much greater.

Water pollution can be divided into two categories: surface water pollution of lakes, rivers, and streams; and ground water pollution of underground water reservoirs called "aquifers". About 40 percent of Ontario's population obtains its drinking water from ground water that comes from wells of one sort or another. For this reason, pollution of ground water is a very serious occurrence. Natural purification processes below ground are very slow, adding further to the seriousness of ground water pollution. This is why sanitary landfill methods of solid waste dis-

posal, as well as other potential sources of ground water contamination, are now being watched so closely by the Ministry of the Environment. Organic matter in discarded waste decays or ferments and persistent materials such as salts percolate down to the aquifers.

Surface water pollution can come from many sources. Some of the major classes of pollution are: natural, domestic, industrial, municipal storm drainage, and agricultural. The natural source has already been dealt with. In most areas of Ontario, it does not seriously interfere with water use.

Domestic and industrial wastes in most municipalities are carried to municipal sewage treatment plants by a network of sanitary sewers. At the treatment plant, most of the polluting material is removed. The remaining wastewater is disinfected and discharged to a nearby lake or river. In many cases, the waste treatment is adequate and water quality and use in the vicinity of the discharge area are not impaired. In some instances, however, treatment does not eliminate all polluting materials, and unsatisfactory water quality conditions persist for many miles downstream from the discharge point.

Municipal storm drainage, along with run-off water from streets, parking lots, and roofs

Chemical content of water

Symbol	Substance	Source	Effect
SiO_2	Silica	Clay minerals, opal, rock minerals	Forms scale on boilers and steam turbines, inhibits pipe corrosion.
Fe	Iron	Igneous and sandstone rocks, iron pipes, pumps, storage tanks, etc.	Stains plumbing fixtures laundry and cooking utensils; spoils water taste and color.
Mn	Manganese	Soils and sediments, metamorphic and sedimentary rock.	Has undesirable taste, leaves deposits on food during cooking, stains plumbing fixtures and laundry.
Ca	Calcium	Gypsum, calcite clay, limestone, rock minerals.	Combines with other minerals to form scale in boilers; inhibits formation of soap suds.
Mg	Magnesium	Limestone, clay, rock minerals.	Same effects as Calcium.
Na	Sodium	Clay, sediments, industrial wastes, rock minerals.	Produces scale and corrosion in boilers; combines with potassium carbonate to cause wood deterioration.
K	Potassium	Micas, clay, rock minerals.	Same effect as Sodium.
HCO_3	Bicarbonate	Limestone.	Combines with other minerals to form scale in pipes.
CO_3	Carbonate	Limestones.	Same effect as bicarbonate.
SO_4	Sulphate	Oxidation of sulphide ores, sulphate minerals, industrial wastes.	Forms scale, causes bitter taste, may be cathartic.
Cl	Chloride	Sedimentary and igneous rocks, salty water forced upstream into tidal estuaries.	Has a salty taste, can be harmful to health.
F	Fluoride	Rock minerals, fluorite, mica.	Increases resistance to tooth decay but, in excess, may cause mottling of tooth enamel.
NO_3	Nitrate	Atmosphere, legumes, plant debris, animal excrement, nitrogenous fertilizers, sewage.	Has a bitter taste, harmful in excess, especially to infants.
$CaCO_3$	Calcium Carbonate	Limestone.	Inhibits formation of soap suds, forms an insoluble scum or curd in washing machines.

of buildings, following a rainfall, are directed to a complex drainage system. In most municipalities, this storm drainage system is independent of the sanitary sewer system. The storm drainage is directed to the nearest water course, usually without any form of treatment. However, some municipalities with old sewer systems have storm drainages flowing into sanitary sewers and then to the sewage treatment plant. This presents one major drawback. Following a heavy storm, a portion of the storm drainage, combined with the domestic and industrial effluent it carries, is bypassed directly into a water course because the sewage treatment plant cannot process such large volumes. This direct discharge generally receives no treatment, or at the very most, disinfection.

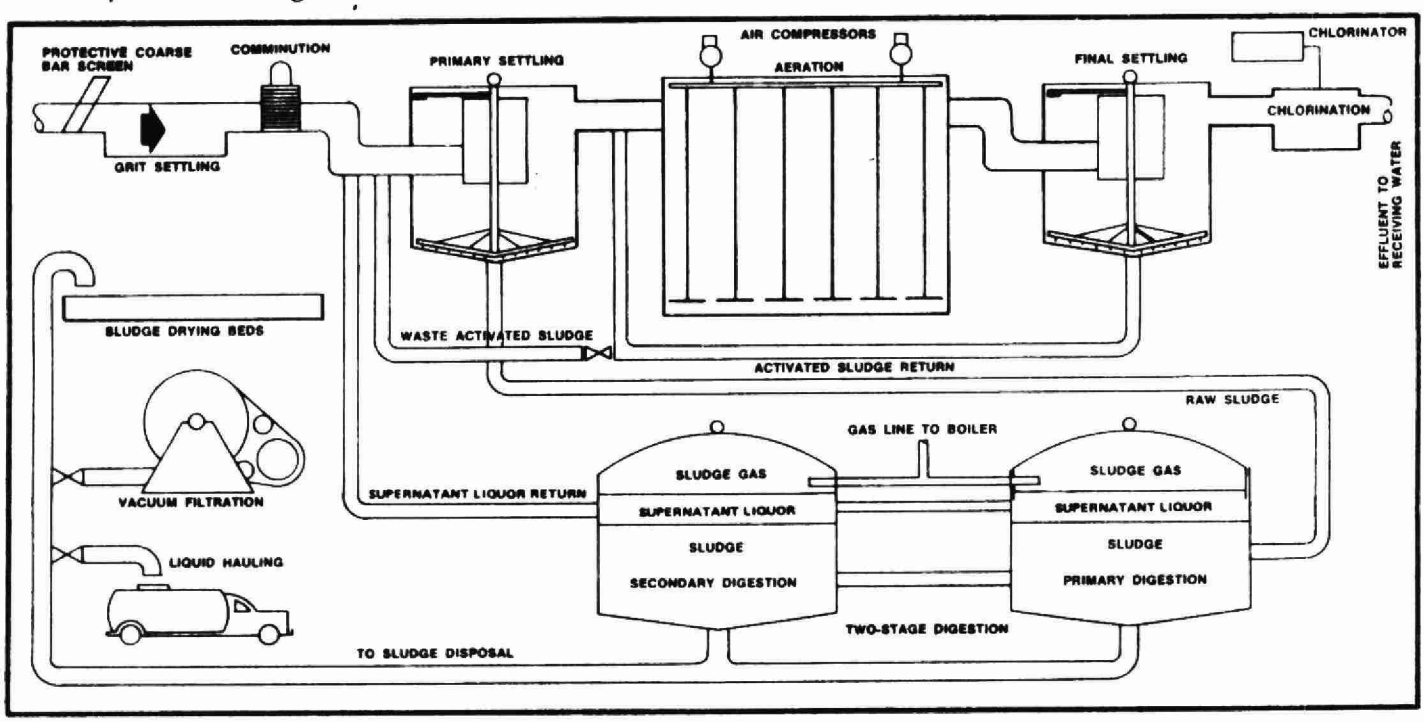
Agriculture also contributes to water pollution. Materials such as fertilizers and pesticides are continuously washed from the surface of the land by sheet erosion in spring or by heavy downpours at any time when the ground is bare. They also percolate through the soil to end up in rivers and lakes. In the case of tile-drained fields, they are carried by the drains into ditches, and from there to water courses. Drainage from feedlots, silos, and manure piles are other sources of pollution from agricultural activities.

Pollutants can be subdivided into two general classes: organic and inorganic wastes. **Organic wastes** use oxygen, and are therefore capable of being reduced to stable substances by biological treatment or by natural processes in a water course utilizing micro-organisms and oxygen dissolved in the water. **Inorganic wastes,** on the other hand, are comprised of salts, heavy metals, and particulate matter such as clay and sand, plus many other components. Some inorganic wastes can be removed by physical or chemical means, but conventional waste treatment methods are usually ineffective in removing many of these waste materials.

High on the list of organic pollutants is the material associated with **bacteriological pollution** — the fecal or natural body wastes of man and animals. When water contains a high fecal bacteria count, it suggests that disease-carrying organisms may also be present. That is why a high fecal coliform count indicates the possible presence of disease bacteria and viruses. Infectious hepatitis, diarrhea, dysentery, and typhoid are a few of the diseases carried by water.

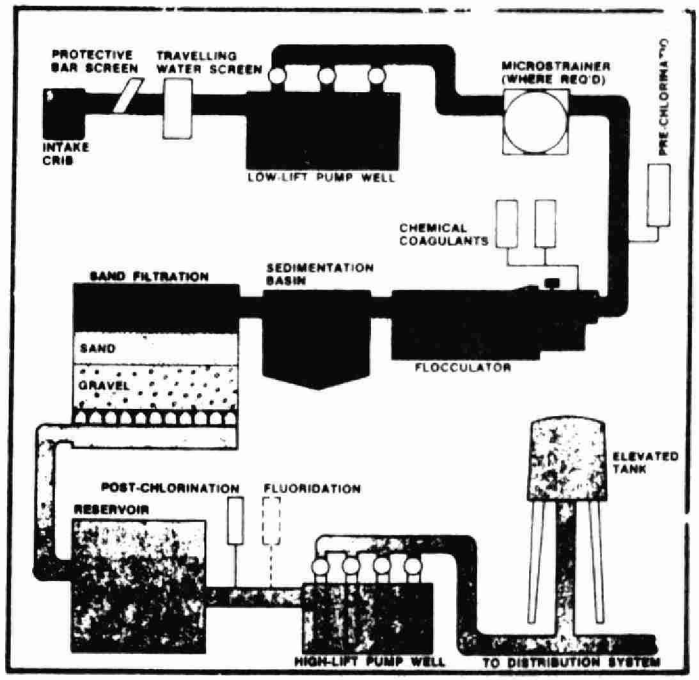
In order for water to be considered satisfactory for drinking, it must classify with a '0' coliform count on at least monthly samples. Guidelines for water quality for municipal supplies, as well as agricultural and industrial uses, are contained in a publication of the Ministry of the Environment entitled "Guidelines and Criteria for Water Quality Management in Ontario".

Bacterial pollution generally stems from inadequate disinfection at sewage treatment plants, from septic tanks that are opera-



POLLUTION CONTROL, SECONDARY TREATMENT - ACTIVATED-SLUDGE PROCESS. Raw wastes are first passed through protective coarse screens to remove large material. This is followed by grit settling where inorganic matter is precipitated out before the wastes are passed through a comminutor that shreds the remaining solids. Primary settling is next where organic solids are collected and piped as raw sludge to the primary digestion tank. Liquid wastes drawn from the top of the primary settling tank are passed to the aeration tank where micro-organisms, promoted by air pumped into the tank contents, oxidize the organic fraction of the waste. This oxidized waste is then held for a brief period in a final settling tank - the sludge thus settling being termed activated sludge, which is pumped back to the inlet of the aeration tank. Clarified liquid decanting from the settling tank is chlorinated before discharge. Sludge collected in the digesters is held in a closed environment where anaerobic bacteria further oxidizes it. Supernatant liquor drawn from each digester is piped back to the inlet of the primary settling tank; sludge-gas, generated by the digestion process, is either flared off or used to produce heat. Fully digested sludge is piped away for disposal.

WATER SUPPLY - SURFACE WATER SOURCE. Raw water drawn from a surface supply is first passed through a protective bar screen to remove large objects and debris. Next, a travelling screen removes smaller solid objects before low-lift pumps raise the water to the treatment plant. Should water conditions demand it, a microstrainer is employed to remove algae and large particulate matter. Following pre-chlorination, chemical coagulants are added and the water is passed through a flocculation tank where gentle mixing takes place prior to settlement in a sedimentation basin. Any finely suspended matter still remaining in the water is then removed in the filter bed, from which the water is passed to a reservoir. Finally, following post-chlorination (and fluoridation in some cases), the now treated water is pumped to an elevated tank and into the distribution system.



ting poorly or have been poorly installed, or from drainage from farm barnyards and livestock feedlots. Technology to control this type of pollution has been available for many years.

Phosphorus is another waste constituent of importance. It can be present in large quantities in domestic sewage, industrial waste, and agricultural discharges. Phosphorus is a primary nutrient, and is necessary in small quantities to sustain aquatic micro-organisms which constitute the base of the aquatic food chain. However, when present in large quantities, phosphorus can promote and sustain excessive growth of algae and other aquatic plants which results in "algal blooms" and in streams and rivers being choked with aquatic plants. The results can be harmful to fish and can impair the recreational uses of the waterway in question.

Chemical precipitation at sewage treatment plants can remove about 80 percent of the phosphorus contained in raw municipal sewage. By 1976, most municipal sewage treatment plants in southern Ontario will be using the chemical precipitation process to remove phosphorus. Many plants are already doing so. Studies are currently underway to determine the magnitude and significance of phosphorus pollution from agricultural land drainage. Control measures to halt the spread of water-polluting phosphorus from this agricultural source will also be evaluated and implemented as required.

Municipal and industrial sewage, urban storm runoff, agricultural drainage, and most other sources of wastewater contain a variety of other polluting materials such as particulate solids, salts, and heavy metals. Conventional waste treatment methods can remove only some of these materials. However, salts and dissolved metals are persistent and can pass through a sewage treatment plant virtually untouched. Even natural purification processes in the waters receiving these pollutants cannot remove them. As a result, the level of these undesirable materials builds up in lakes and rivers to the point where it can adversely affect the quality of municipal drinking water, and even supplies of water for irrigation and industrial use. Aquatic life can also be threatened by these persistent pollutants. Studies to evaluate the environmental impact and possible control procedures for these pollutants are continuing.

What Can Be Done?

It is apparent that nearly all of man's activities and many of the forces of nature contribute to some degree to water pollution. The natural sources of pollution cannot be eliminated, but for the most part natural pollution is insignificant when compared to pollution from man-made sources. It is everyone's responsibility to eliminate pollution and protect our waterways.

Governments at all levels have a role to play. The federal government can provide funds, facilities, and leadership for research and development of treatment and reclamation techniques. The provincial government can provide funds for construction of sewage treatment plants and reclamation. It can develop province-wide policies and procedures and undertake surveillance programs and special studies to aid in solving special problems. Municipal governments must ensure that sewage treatment plants within their municipalities are operating at maximum efficiency. They can improve their sewer systems to eliminate discharges of untreated wastewater. They must not allow solid waste disposal to contaminate ground water sources.

Industry can minimize pollution by recirculating water, establishing reclaiming and recycling processes for industrial wastes, and implementing special waste treatments prior to discharging sewage into municipal sewers or water courses. Individual citizens can assist by such means as conserving water and ensuring that waste disposal systems in the home and cottage are operating properly.

The biggest responsibility of the citizen,

however, is to become involved in environmental issues and to demand action from all levels of government and industry in the continuing battle against water pollution. Pollution is everyone's business.

1) Don't use lakes, streams or sewers as dumping areas for toxic materials. (weed-killers, insecticides, fertilizers, oil, paint or other wastes insoluble in water)
2) Endorse the construction of modern sewage treatment plants in your area.
3) When operating a pleasure boat (motor boat) make sure you do not have undue oil or gas spillages in the water. Wastes should be retained in a holding tank and disposed of on shore.
4) Keep river banks and shorelines clear when camping.
5) The use of pesticides and herbicides should be kept to a minimum.
6) Use low phosphate detergents.
7) Avoid discharging the following into a sewage or septic tank system: flammable or explosive materials (gasoline, benzene, etc.), corrosive or poisonous wastes (acids, pesticides, photographic chemicals, arsenic, etc.), large amounts of solids (feathers, sand, metal, wood, bones, paper, disposable diapers, etc.), grease or oils. These materials either are unsafe, will overload or upset sewage treatment processes, or will upset the environment into which the sewage is disposed.
8) Don't leave water taps running as this wastes our treated water supply.
9) Support citizen and government groups working for a better environment.

Some Activities For Students Studying Water Pollution

1. List as many natural sources of water pollution as you can.
2. List, in what you consider to be their order of importance, the man-made sources of water pollution.
3. Explain, with examples, the two general classes of pollutants.
4. Phosphorus in large quantities is a water pollutant. Explain why.
5. Discuss what you consider the role of governments — federal, provincial and municipal — should be in water pollution ?
6. What other things, besides those mentioned in this fact sheet, can citizens do to combat water pollution ?
7. Visit a local water or sewage treatment plant and attempt to get an interview with the plant manager to discuss the problems related to plant operations.
8. Obtain, through your teacher, films on water and/or water pollution such as;
   i) **River With A Problem,** 28 min., color, National Film Board;
   ii) **The Rise And Fall Of The Great Lakes,** 16 min., color, National Film Board;
   iii) **The Invisible River, The River Must Live,** or **Environment Ontario,** available from Modern Talking Picture Service, 1943 Leslie Street, Don Mills, Ontario. (phone 1-416-444-7347)
9. Obtain further reading material on the subject of water pollution. A few of the many possible books include;
   i) **Freshwater Pollution** by Peter Larkin, McGill-Queen's University Press, Montreal, 1974;
   ii) **What You Can Do About Pollution** by John Fisher, Longmans, Don Mills, 1971;
   iii) **Guidelines And Criteria For Water Quality Management In Ontario,** Ontario Ministry of the Environment, July, 1974.
10. The accompanying table lists the physical and chemical water quality criteria used by the Ministry of the Environment for public surface water supplies (note the microbiological and radioactivity criteria are not included).

    Since treatment processes exist which can convert any raw water (with a few minor exceptions) to potable water, it is necessary to define a commonly accepted treatment system which can produce a potable water at a reasonable cost. For the purposes of the criteria, such a system has been defined to consist of coagulation, flocculation, sedimentation and rapid sand filtration; the use of chemicals is restricted by definition to the commonly used coagulants and chlorine for disinfection.

    Two types of criteria have been established, namely the Permissible Criteria and the Desirable Criteria. Waters meeting both of these criteria are acceptable for treatment by the defined treatment process stated above. Waters meeting the Desirable Criteria provide for a greater margin of safety.

It should be borne in mind that the values given under the Permissible Criteria cannot be considered as maximum single sample values. These criteria should not be exceeded over substantial portions of time. If this should occur, then it will become necessary to determine the cause and initiate corrective action. The frequency and variety of sampling should be based on the findings of a comprehensive pollution survey.

As an advanced study, a student may wish to research the importance (public health aspects) of any one or more of the water constituents listed in the accompanying tables.

WATER QUALITY CRITERIA FOR PUBLIC SERVICE WATER SUPPLIES.

(Unless otherwise indicated, units are mg/l.)

Constituent or Characteristic	Permissible Criteria	Desirable Criteria
Physical		
Colour (platinum-cobalt)	75 units	< 5 units
Odour	Readily removable by defined treatment	Absent
Turbidity	— do —	Absent
Temperature	85°F	Pleasant tasting
Inorganic Chemicals		
Ammonia	0.5 (as N)	< 0.01
Arsenic*	0.05	Absent
Barium*	1.0	Absent
Boron*	1.0	Absent
Cadmium*	0.01	Absent
Chloride*	250	< 25
Chromium* (hexavalent)	0.05	Absent
Copper*	1.0	Virtually absent
Dissolved Oxygen	≥ 4 (monthly mean) ≥ 3 (individual sample)	Near saturation
Fluoride*	See footnote (1)	1.0
Hardness*	Acceptable levels will vary with local hydrogeologic conditions and consumer acceptance.	
Iron (filterable)	0.3	Virtually absent
Lead*	0.05	Absent
Manganese* (filterable)	0.05	Absent
Nitrate plus Nitrite*	10 (as N)	Virtually absent
pH range	6.0 - 8.5 units	Least amount of interference with treatment process
Phosphorus* (phosphates)	Not encourage growth of algae or interfere with treatment process	
Selenium*	0.01	Absent
Silver*	0.05	Absent
Sulphate*	250	< 50
Total Dissolved Solids* (filterable residue)	500	< 200
Uranyl Ion*	5	Absent
Zinc*	5	Virtually absent
Organic Chemicals(2)		
Carbon chloroform extract* (CCE)	0.15	< 0.04
Cyanide*	0.20	Absent
Methylene blue active substances*	0.5	Virtually absent
Oil and grease*	Virtually absent	Absent
Pesticides		
Aldrin*	0.017	— do —
Chlordane*	0.003	— do —
DDT*	0.042	— do —
Dieldrin*	0.017	— do —
Endrin*	0.001	— do —
Heptachlor*	0.018	— do —
Heptachlor epoxide*	0.018	— do —
Lindane*	0.056	— do —
Methoxychlor*	0.035	— do —
Organic phosphates plus carbamates*	0.1	— do —
Toxaphene*	0.005	— do —
Herbicides		
2,4-D plus 2,4,5-T, plus 2,4,5-TP*	0.1	— do —
Phenolic Substances*	Virtually absent	— do —

* The defined treatment process has little effect on the constituents.

(1)

Annual Avg. of Max. Daily Air Temp. F.	Recommended Limit for Fluoride mg/l
50.0 to 53.7	1.7
53.8 to 58.3	1.5
58.4 to 63.8	1.3

(2) Organic chemicals should not be present in concentrations as to cause adverse tastes and odours which cannot be removed by the defined treatment and/or by chlorination only

FACTS

FOR ENVIRONMENTAL STUDIES

Ministry of the Environment
Ontario

ABOUT PESTICIDES AND THE ENVIRONMENT

Until 1939, only a few inorganic chemicals and natural plant products such as derris and pyrethrum were available for pest control. However, in 1939, the ability of the chemical compound DDT to control disease-carrying insects was discovered. This was followed, in 1945, by the discovery of a plant-control compound known as 2,4-D. Within the next decade, many other chlorinated hydrocarbon compounds such as benzene hexachloride, heptachlor, aldrin, and dieldrin were developed.

Although these insecticides were efficient, it was discovered that they also remained active in the environment for long periods of time. For this reason, they could be accumulated in living organisms, possibly posing a hazard to health or causing undesirable effects on the environment.

Within the last 15 years, new pesticides in the organophosphorus and carbamate groups have been developed. These pesticides have a relatively shorter life span in the environment because they break down, by various means, into simpler non-offensive substances. Some of these chemicals break down by oxidizing (reacting with oxygen in the air or environment), hydrolizing (reacting with water), or being metabolized (being attacked by an organism and broken down).

An ideal pesticide is one which is highly effective against the target pest but, at the same time, safe to all other life forms. It should break down, within a reasonable period of time, to harmless products. It should also be easy to apply, harmless to equipment and property, and economical to use.

With these goals in mind, chemists in research and industry endeavour to develop new pesticides which will be effective on specific pests. The chemicals are then submitted to various tests in the laboratory, greenhouse, and field which may last from three to six years. Initial tests involve effectiveness on the intended pests and the evaluation of any potential hazards. Potential threats to the environment are evaluated as well.

Subsequent tests are carried out to determine toxicity levels and effects of these pesticides on a variety of organisms, including molluscs, micro-organisms, plants, food-chain components such as algae, insects, and small animals. Long-term exposure tests are carried out to determine possible mutation, cancer-forming, or other long-term deleterious effects of the chemical.

Complete documentation of these studies is submitted to the Control Products Section of the federal government body, Agriculture Canada, for consideration for registration of the chemical as a pesticide. Registration may be given under the Pest Control Products Act and Regulations. At the same time, documentation is submitted to the Ontario Pesticides Advisory Committee for the pesticide to be classified and scheduled into the Pesticides Act 1973 and Regulations.

Registered products are continually monitored for adverse environmental effects. In Ontario, the Pesticides Act and Regulations provides means for swift action should problems arise from any particular pesticide.

What is a Pesticide?

Basically, a pesticide is a substance that kills or controls some unwanted organism. The legal definition of a pesticide under Ontario's Pesticides Act and Regulations is: "....any organism, substance, or thing that is manufactured, represented, sold, or used as a means of directly or indirectly controlling, preventing, destroying, mitigating, attracting, or repelling any pest or of altering the growth, development, or characteristics of any plant life that is not a pest."

From this, we can see that the term "pesticide" is a very general one. A more accurate way to classify pesticides is by their intended targets. Such classification has derived the following terms:

- insecticide — a substance which kills or controls insects;
- fungicide — a substance which kills or controls fungi;
- herbicide — a substance which controls or kills undesirable plants;
- rodenticide — a substance which kills rodents such as rats and mice;
- miticide — a substance which kills or controls mites;
- nematocide — a substance which kills or controls nematodes.

Many other, more specialized terms apply to the control of more specific pests.

Government Supervision of Pesticides

For a pesticide to become available for use in Canada, it must be tested extensively and must satisfy the Control Products Section of Agriculture Canada as to its safety and efficacy in use. It must also comply fully with the Federal Pest Control Products Act, the Federal Food and Drug Act, and the Canadian Environmental Protection Act. In Ontario, the safe use and management of pesticides is outlined under the Pesticides Act and Regulations which is enforced by the Pesticides Control Section of the Ministry of the Environment. The Ministry licenses and supervises all vendors and commercial applicators of pesticides. The Ministry also advises the home-owner and licensed applicator on the proper use of pesticides.

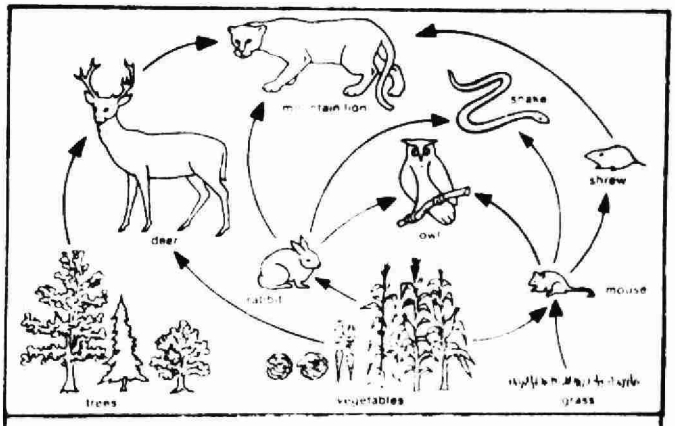
In addition, classification of pesticides is made by the Ontario Pesticide Advisory Committee. This committee is composed of experts from the agricultural and chemical industries, universities, and a number of government agencies. These classifications, when adopted, become amendments to existing legislation. An important example is the restriction of the use of persistent chlorinated hydrocarbon insecticides such as DDT, aldrin, dieldrin, and heptachlor, which has been in effect in Ontario since January, 1970. In 1971, endrin was removed from agricultural use as well.

Pesticides residue in soil, drinking water, food, and animal feed are continuously being monitored by the Ontario Ministry of the Environment, the Ontario Ministry of Agriculture and Food, the Food and Drug Directorate (Health and Welfare Canada), Environment Canada, and other provincial and federal government agencies.

What are Pesticide Residues?

The term pesticide residue refers to quantities of pesticide which may remain after the application of a chemical has been completed and the pest controlled. Also, quantities of pesticide may contaminate non-target organisms, resulting in a residue which may or may not pose a health hazard.

If you consider a food chain, it is possible to see how a persistent pesticide could accumulate to a hazardous level, even though it is safely used. When a forest or field is sprayed with an insecticide to preserve valuable trees or crops, this insecticide is picked up by numerous non-target insects. A frog, for example, may eat hundreds of these insects within a few days and may concentrate some of the pesticide within the tissues of its body. If a snake eats a couple of dozen contaminated frogs, it could concentrate the initial insecticide dose several thousand times. If a hawk then consumes a number of snakes, it may concentrate enough of the pesticide to biologically affect the hawk by lowering its reproductive potential. This has been the major reason for restriction of chlorinated hydrocarbon compounds in the past five years.



Many food chains, considered together, make up more complicated food webs.

Pesticide residues from chlorinated hydrocarbons have caused a number of well publicized problems. For example, in birds, DDT accumulation has interfered with shell formation of eggs so that shells broke during incubation. In fish, pesticide residues have interrupted mating behavior or produced eggs which would not hatch. In some mammals, DDT and its derivatives have accumulated in the fatty tissues of the body. When these reserves are used, as during times of weight loss, the pesticide is brought into circulation where it may cause complications.

The prevention of residue problems is one of the main reasons that pesticides are so thoroughly tested before licenses for their manufacture and sale are granted. This is also why pesticide users are issued strict recommendations as to how a pesticide must be used and in what dosage. In the case of existing residues, monitoring is continuously being carried out by a number of government bodies.

Sources of Pesticide Residues

Pesticides enter the environment in one of two ways: either directly, through pesticide application; or indirectly, through a number of actions, many of them stemming from unwise handling of the pesticides.

Direct application of pesticides is carried out to affect pest control in animals, crops, soils, buildings, and water. Indirect addition of pesticides to the environment may occur through improper disposal of pesticides or cleaning of spray tanks, dumping of pesticides into sewage systems and dumping of food products containing high residue levels.

Another source of indirect pesticide entry is drift. Pesticides in the air may return to earth in rain or snow, at some distant point where the substance may never have been used. This is the reason for pesticide residues in snow and in non-migratory animals of the Arctic and Antarctic regions. Pesticides may also be added to the air through the escape of fine droplets of chemical during ground or aerial spraying; evaporation of residues; the blowing of wind-eroded soil particles containing pesticides; smoke from manufacturing processes; and a number of other minor causes.

Legislation at both federal and provincial levels has been implemented to prevent both direct and indirect additions of pesticides to the environment. However, legislation alone will not solve the associated problems. Extensive education programs aimed at farmers, market gardeners, orchardists, foresters, commercial applicators, and even amateur gardeners have been set up by various government bodies to acquaint these people with the proper use and handling of pesticides.

Other Pest Control Methods

The use of pesticides is not the only method of protecting ourselves, our food, and our environment against pests. Other methods are being used, and new methods developed. Some of the more common methods are listed below.

Mechanical Means: For the homeowner or occupant of a small area, an efficient means of control is individual removal of pests. Pulling weeds from the garden, swatting flies in the house, and airing damp areas to discourage growth of fungi are all mechancial means of control. These methods are effective on small problems, but are generally impractical on a wide scale.

On a larger scale, farmers use a number of different, specialized implements such as discs and mechanical hoes to control weeds. Research is also being conducted to design practical weed harvesters to remove nuisance plants from water.

Traps: Often, the best means of control on a small scale may be traps. This may mean mechanical mouse traps around the home or insect traps which employ an attractant light or chemical to trap insects. Again, traps are useful only on a small scale.

Sanitation: Proper maintenance of landfill sites, industrial and household wastes and elimination of stagnant water will assist in controlling a number of pests because habitat for breeding and development of the pests is removed. For example, many mosquito species require still, grassy water for egg-larva development; rats require food which is readily available in open dumps of household food; flies lay their eggs in open manure piles about the farmyard where the maggots develop. Sanitation can mean a reduction in pests.

Fire: Occasionally a supervised fire may be useful to destroy a pest which cannot escape by moving away. An example of this may be seen in farm fields for removal of a particular weed.

Sound: The emission of inaudible, ultra-high-frequency sounds within a building may deter a particular pest from infesting the structure. Research has been carried out on sounds to repel rats, mice, and beetles from stored crops or to discourage birds from nesting on high buildings.

Sterilants: The use of sterilants relies on the production of sterile male insects by chemical, genetic, or radioactive means. These unproductive males are then released into the population where they will mate with normal females, but the eggs produced will be infertile. This method of control is effective on a smaller scale, with pests of limited mobility.

Cultivation Limitations: Occasionally a pest may be destroyed by delaying crop planting until after a critical stage in the development of the pest, or by good crop rotation. For example, grasshopper eggs will be buried if plowing is delayed until after the mating period, thereby controlling this pest population. Planting of a rapid germinating and fast growing crop in fields where a slow growing weed exists will result in successful competition by the crop, with subsequent stunting or death of the weed.

Resistant Species: Some crops and ornamental plants have been developed which can resist or withstand attacks by specific pests. Examples here are rust- and smut-resistant wheat. However, these resistant plants may remain resistant only until new generations of the pest develop which can overcome the resistance.

Biological Controls: Biological controls consist of encouraging natural predators, parasites, or diseases of the pest. Biological controls generally require much research and study before they can be implemented. Beneficial insects should be recognized and protected by everyone.

Monitoring: Some experiments have been carried out on agricultural crops with the goal of producing a more efficient, economical application of a pesticide by using a smaller quantity. By monitoring the insect activity or the disease, a more specific timing of the pesticide application can also be made. In this way, it is possible to eliminate more frequent preventive applications.

Often on a wide scale, combinations of many of these methods are employed to control pests. Alteration of the methods may be useful or necessary as conditions vary and as the pest becomes resistant to any one particular method.

BENEFITS OF USING PESTICIDES

Pesticides are used to maintain mankind's standard of living and to support increasing populations through protection of agricultural produce, forests and forest produce, and human health and comfort.

It is estimated that one-third of Canadian crops, valued at $1500 million, is lost annually to nuisance plants, insects, diseases or other pests. For example, a study of farm weeds showed that these competing plants reduced the average yield by 15 per cent, but that individual areas suffered up to a 60 per cent decrease in yield. It is estimated that Canadian farmers lose $500 million in crops through competition by weeds.

Pesticides not only help to increase the yield of food crops but also serve to maintain a higher quality of food which the consumer expects. Both of these advantages aid in keeping the cost of food lower than if pesticides were not employed.

It is obvious that many areas of public health have been improved through chemical control of disease-carrying pests. Incidence of diseases such as equine encephalomyelitis, malaria, typhus, yellow fever, and many others have decreased because of the control of biting insects.

For conservation purposes, control of pests in parks and forests ensures healthy trees and plants. Entire forests have been saved by pesticides from destruction by gypsy moths and spruce budworms. For management of water systems, pesticides are used to control algae, weeds, parasite-carrying snails, leeches, lampreys, and populations of undersirable fish. In this way, higher populations of desirable fish are maintained by controlling some of their pests and diseases. More attractive and functional recreational waters are maintained through management of water weeds, algae, and other pests.

The best method of controlling pests is an integrated one wherein several of the methods of pest control are employed. However, if world health and food production are to be maintained and improved, pesticides are an essential asset.

Suggested Reading

1. **Pesticides and the Living Landscape** by R. L. Rudd, Faber and Faber, London, 1965.
2. **Pesticides and Pollution** by K. Mellanby, Collins, 1967.
3. **Silent Spring** by R. Carson, Houghton Mifflin, 1962.
4. **Since Silent Spring** by F. Graham, Houghton Mifflin, 1970.
5. **Pollution Probe** by D. A. Chant, New Press, 1970.
6. **Beneficial Insects** by L. A. Swan, Harper and Row, 1964.

Questions for the Reader

1. For each classification of pesticide, give an example of a pest which may be controlled.
   eg. insecticide — mosquito.
2. What is a food chain? Give two examples of complete food chains.
3. Describe at least two different means of controlling the following pests about the home:
   (a) mosquitoes in the backyard;
   (b) dandelions in the lawn;
   (c) aphids in the rose garden;
   (d) maggots in outdoor garbage cans;
   (e) moths in the closet;
   (f) mice in a cold cellar;
   (g) ants in the food cupboard.
4. Mosquitoes flourish in still, grassy pools of water. Name some means of discouraging them.
5. (a) Name some advantages of using pesticides.
   (b) Name some disadvantages of using pesticides.

Student Projects

1. From a pesticide in your home (e.g. Raid, Vapona strip, moth balls), read the label and determine the following:
   (a) the pest which the pesticide affects;
   (b) the primary active chemical in the product;
   (c) any special precautions you should take.
2. Write a brief report on the life cycle of one of the beneficial insects. State why this particular insect is considered beneficial.
3. Collect ten weeds from a garden or farm field. Identify each weed.
4. Collect ten insects from either indoors or outdoors. Identify each insect and explain whether it is beneficial or harmful.

—No pesticide should be used where it could contaminate air or water supplies.

—Weigh the benefits of using the pesticide against the harmful effects.

—Always read the instructions carefully and follow them. Never use too much pesticide to get those last few bugs, most of them will die by natural means.

—Use a black-light or ultra high frequency device to control backyard pests rather than spraying.

—If you have a rodent problem, either use mouse-traps or buy a cat.

—Set out stale beer in a bowl at night to attract and kill snails and slugs.

—If you are only bothered by a few pests, remove them by hand. Aphids and mites can sometimes be removed by a spray of mild soap and water, plain water or a light oil if the plants are subject to mildew or rot.

—Never use chlorinated hydrocarbon pesticides such as the ones similar to DDT.

—Never use products that contain heavy metals such as lead, arsenic or mercury.

—Most household pests can be controlled with means other than chemical pesticides with the exception of carpenter ants or termites. Consult a professional exterminator or the local pesticide branch of the Ontario Ministry of the Environment before using any large amount of pesticide.

—Never pour onto the ground or into a water supply finished pesticides and especially do not incinerate old products.

—When in doubt about anything to do with pesticides, phone the Pesticides Control Section of the Ministry of the Environment.

FACTS

FOR ENVIRONMENTAL STUDIES

Ontario Ministry of the Environment

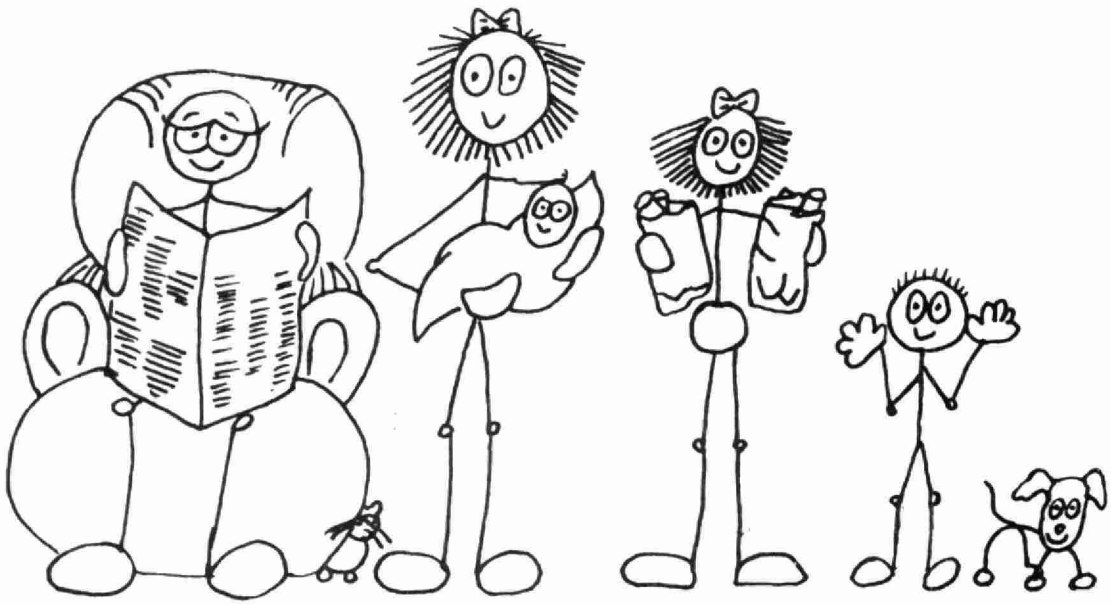
ABOUT WASTE

WHAT CAN ONE FAMILY DO?

(This fact sheet was prepared for students and teachers interested in learning about their environment.)

These tips to change some of our polluting ways were compiled originally be the Real Estate Board of Greater Vancouver. The suggestions that follow have been reprinted by permission with a few minor changes to suit Ontario conditions.

This fact sheet will be revised with additional suggestions from you included. Ontario residents with recommendations are invited to send their ideas to the Educational Resources Co-ordinator, Information Services Branch, Ministry of the Environment, 135 St. Clair Avenue West, Toronto, Ontario M4V 1P5.



BE A BACKYARD ECOLOGIST

Plan "green survival" for your own home environment. Trees help cool the air through transpiration, evaporation and summer shade. In winter they reduce wind velocity. They absorb polluted air and release air richer in oxygen and free of contaminants. Foliage screens dust and other solid pollutants from the air, and also reduces the noise pollution of streets, factories and industrial areas.

Plant materials protect soil, holding it against silting into rivers and streams, and minimize run-off from higher areas. Plants are pollution detectives, too — air pollution injury to plants will be visible before effects can be noted on animals, materials or metals.

Timely Tips

1. Check your local university agriculturist or the Pesticides Control Section, Pollution Control Branch, Ministry of the Environment about results from organic pesticides like rotenone or pyrethrum. Check all chemicals you intend to use with the Pollution Control Branch. Organic gardening books often can provide alternatives to chemicals.

2. Natural controls can be effective. Nasturtiums and chives repel aphids. Hot, soapy water kills aphids, too. A light over a tub of water will attract and destroy flying insects. A burning torch of rolled newspaper will do away with a caterpillar tent.

3. Wasps chew the bugs that defoliate fruit trees; honeybees pollinate flowers; spiders help keep down the destructive insect population. You might remember these facts before making a clean sweep with insecticides. Nature built in many insect-population controls.

4. Saucers of beer placed strategically around your garden will mark the end of slugs but should be placed out of reach of inquisitive children or pets. You could also screen plants with tiny, four-inch fences of windowscreen or go night-slugging with a flashlight and pour a little salt on each slug. Ten minutes per night for a few weeks would solve the problem.

5. Another of nature's insect controls is birds. Bring them back by reducing chemical sprays and providing feeders. (Kitchen fat congealed on a foil plate with a mixture of bird seed or dry cereal added is a special winter treat for birds.)

6. Rotate your planting areas to confuse the pests. Remember, humus is important to soil fertility so keep a compost heap with all wet kitchen garbage, grass clippings, coffee grounds and tea leaves. Coarse material can be dug into beds; fine material is a good top dress. If you cut your lawn often, clippings are high in natural nitrogen and potash which are necessary for your lawn, so why not get this benefit instead of spending time and money on extra chemicals?

CHANGE YOUR CONSUMER HABITS

Save our shrinking forests — don't waste paper products but, remember, those you must use can lead a double life;

1. BUY QUALITY . . . some goods are made to be used and discarded and some are made to be used and repaired and used . . .

Make the right choices.

2. BUY . . . de-inked, recycled paper whenever possible for office and home use. Decomposable containers are biodegradable but plastic isn't. Bottles can be re-used for home canning and storage. Plastic containers — if unavoidable — can become fridge keepers, flower pots, craft items; don't overbuy plastic containers — they do not degrade and the petroleum used in plastic manufacture is not a renewable resource;

3. CUT DOWN . . . on heavy Christmas card mailing and ornate gift wrapping;

4. LIVING . . . Christmas trees are beautiful and can grace your garden or patio for years;

5. REVERSE . . . modern trends! Cloth wipes better than paper towelling; easy-care fabrics eliminate the need for paper napkins and tablecloths. Lunch kits are hardier than brown bags. String bags carry groceries better than paper bags;

6. COLORED . . . paper products may cause no more damage than bright-white paper that has been heavily bleached. Choose less bleached papers for all uses;

7. REMEMBER . . . Cubs, Scouts, Brownies and Girl Guides have been environmentalists for years — they collect paper and bottles, and recycle them. Refund money helps support their organizations;

8. RE-USE . . . envelopes you receive. Paste on a new address label and give it another trip. Some organizations actually re-use letters, employing the blank back sides as note or memo paper.

HOUSEHOLD EQUIPMENT — conveniences or contaminators?

1. Have your furnace checked regularly, filters cleaned or replaced annually, fire-places and furnace flues cleaned regularly. You'll do triple-good this way — save heating money, use less of our non-returnable fuel resources, and avoid the danger of chimney fires.

2. Use your fireplace environmentally. Burn only clean, dry wood — NOT soft coal, which adds to the smoke pall above. NEVER burn kitchen garbage in a fireplace as the temperature isn't high enough to combust it properly.

3. Dripping faucets waste water resources — fix them.

4. Watching certain appliances can save a great deal of electricity and, at the same time, save you money. Is your water heater too big for your consumption, and do you turn it down when away, or when you're not using great quantities of hot water? Save our dwindling hydro resources and yourself a lot of money.

5. If you must use an automatic dishwasher, limit yourself to one load a day — save power and hot water! Phosphates contribute to water pollution. Be environmentally wise by measuring carefully; use LESS rather than the stated quantity. This becomes a double saving because over-sudsing clogs machines and could cause costly appliance repairs.

6. Don't put grease, caustic fluids or filter-tip cigarettes in toilets. Caustics corrode and the others clog public sewage equipment.

7. If you use a septic tank, check your local engineering department for tips on what to flush away. NEVER put facial tissues in the toilet — they are practically indestructible and clog the tank. Chemical dyes may retard normal bacterial action in your septic tank. Follow local septic cleaning regulations regularly.

8. Decrease household garbage bulk remove tops and bottoms and flatten cans; cut plastic bleach bottles in pieces for less bulk; separate paper, glass, metals, etc., and check local recycling agencies for disposal.

CAMPERS — abide by the rules of good citizenship and keep your campsite clean. Keep waste disposal to a minimum by burning combustible materials in your campfire. Remember the household tip of reducing garbage bulk by flattening cans, cutting plastic containers, and dispose all in waste barrels. And remember, if you carried it into a remote area you can carry it out for proper disposal. KEEP YOUR CAMPING OR PICNIC SITE CLEAN FOR THE NEXT GROUP.

HIKERS — if you carry your packsack full on the beginning of your hike, you can carry it back

to a garbage can to dispose of wrappings, bottles, cans, etc. Don't just drop the waste anywhere because there's not a garbage container for miles.

BOATERS — buying a new boat? The Ministry of the Environment enforces regulations which prohibit the overboard discharge of treated or untreated sewage from pleasure boats. Holding tanks and pump-out facilities are required. For additional information contact the local Ministry of the Environment office or write the Ontario Ministry of the Environment, 135 St. Clair Avenue West, Toronto, Ontario M4V 1P5.

Buying a new motor? Inquire after those which do not leave oil and gas slicks on the water.

Carry a little bag in your boat for your own litter or any you might find floating on the water or discarded on beaches.

Remember, plastic bottles, bags, cups, etc., do not decompose or sink and become hazards in waterways. Dispose of these in shore containers.

Keep your boat motor in top shape. Be careful when filling your tank so no gas and oil spillage fouls the water. Old oil should be disposed of at service barges or shore.

CHANGING YOUR DRIVING HABITS

The auto is responsible for about half of all the country's air pollution, including 60 per cent of the carbon monoxide. Learn to depend less on the auto. Buy a bike, walk more and get the benefit of better health as a bonus; campaign for better transportation systems. If you must drive, use these tips.

1. Keep your engine perfectly tuned for most efficient fuel use. Have the positive crankcase valve cleaned regularly. A clogged valve may double your engine's emission. Keep the carburetor properly adjusted. Clean or replace the air filter regularly. A grimy filter can increase emissions by 75 per cent. Use no-lead or low-lead fuels. Keep spark plugs and points in good condition.

2. Don't let your engine idle needlessly — idling produces the highest concentration of pollutants.

3. Double up on use. Join or form a car pool for regular trips.

4. At the gas station, don't let them 'top' the tank — this pollution spillage will be drained into the sewage system.

5. Drive smoothly — fast acceleration and deceleration cause high pollution emission.

6. To protect your own lungs, try to avoid driving in the city during peak traffic hours. If you're stuck in a traffic jam, don't smoke. The combination will increase the amount of carbon monoxide you inhale.

What do you think one family can do?

The Ontario Ministry of the Environment wants your suggestions. Use the return card on this page to send us your ideas so we can share them with other concerned citizens.

STAMP

Ontario Ministry of the Environment
Information Services Branch
135 St. Clair Ave. W.
Toronto M4V 1P5

OTHER DO'S AND DON'TS

DO campaign for tertiary sewage treatment plants in your area and

DON'T complain about the cost, because it's for your health and welfare.

DO shop carefully to avoid spoilage; cook just enough to avoid leftovers or use leftovers in organic compost heaps.

DON'T forget to involve the kids — even the youngest one. They have an even bigger stake in the future of the environment than you. Have a family contest to see who can devise the best anti-pollution plan for your household.

DO become involved and inform yourself about environmental protection. Hysterical protest and indictment of business or governmental action is not constructive. Remember, businessmen and government members are interested in the future too. Work together for progress. Use logic and legitimate facts.

DON'T forget that many agencies are working toward a land-use planning concept that will maintain our corner of the world. Much study and input is needed before final plans can be accepted. Do you have any expertise to add?

DO buy 'RETURNABLES' whenever possible. You will get your deposit money back. The inconvenience is minimal, when one considers the reduction in waste that will result.

DON'T THINK YOUR CONTRIBUTION IS TOO SMALL . . . you, your family and neighbors are a big part of the pollution problem, and play a big role in overcoming it.

ACTIVITIES TO CONSIDER

If you get a chance, visit either an incineration plant, a garbage dump or a landfill site, and discover the true meaning of the waste problem.

If the urge to investigate further ever strikes, carry out your own mini-litter survey of a park or campsite, or school yard. How much of what you find is biodegradable material? What items predominate in your collection? Are there metallic, plastic, or paper products?

If you want to go even further in your experimenting, try making your own mini-landfill site. Bury a small amount of selected garbage, such as some plastic, some plain paper, some waxed paper (such as a shredded milk carton), a couple of crushed metal containers, etc. Give this project a year before unearthing the results.

If you've got the stomach for it, check through a garbage bag sometime. Sort out the contents, and get an idea of your waste contribution. A word of caution; rubber gloves are recommended as is a 'fresh' bag of garbage.

My Suggestion is: